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THE BLUEBERRY MAGGOT

In Washington County

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BULLETIN 308

THE BLUEBERRY MAGGOT

In Washington County[1]

By Edith M. Patch and William Colcord Woods.

Introduction.

Perhaps as unique and interesting an ecological community as may be encountered in the State of Maine is presented by the blueberry barrens of Washington County which comprise a vast area of unforested land in the eastern part of the state, extending roughly from Cherryfield in the west to Machias in the east and including more especially Deblois and the townships numbered 16, 17, 18, 19, 24 and 25. How the barrens originated is a matter of dispute and there are several theories as to their beginning, but at any rate this fact is clear: in this section of the country wherever the forests are removed and more especially when they are destroyed by fire, blueberry bushes tend to spring up in large numbers. The barrens or "plains" consist of great stretches of mostly level or slightly rolling land more or less broken up by lakes and swamps. These together with old fields and pastures and newly cleared woodlands comprise the regions where blueberries are harvested.

Climatic conditions such as characterize the whole coast of Maine prevail here: relatively short summers, which on the barrens are very hot, and long winters during which, however, the plants are usually well protected by snow. The average annual rainfall is 45 inches; typically there is a heavy rainfall followed by a dry period in June, a condition which seems to be favorable to the growth of blueberry bushes. When tested the soil, which is a mixture of sand, gravel and loam, is found to give an acid reaction.

Locally the mountain-cranberry (*Vaccinium Vitis-Idaea* L. var. *minus* Lodd) forms a dense cover over the ground, especi-

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[1]Papers from the Maine Agricultural Experiment Station: Entomology No. 110. This bulletin is in part compiled from Bulletin 244 from this Experiment Station and in part from various unpublished reports by William Colcord Woods, and Edith M. Patch

ally along the sides of little ravines. Huckleberries *(Gaylussacia baccata* (Wang) C. Koch) and chokeberries *(Pyrus melanocarpa* (Michx.) Willd.) are in places very plentiful, while the other more characteristic plants associated with the blueberries are the sheep-laurel *(Kalmia angustifolia* L.), sweet-fern *(Myrica asplenifolia* L.), and young gray birches *(Betula populifolia* Marsh). Less characteristic but common on some parts of the barrens are the alder *(Alnus incana* (L.) Moench), meadow-sweet *(Spiraea latifolia* Borkh) and several species of aster and goldenrod.

Three species of blueberry (all of the so-called low-bush type) occur on the barrens.[2] These are in order of abundance the low sweet blueberry *(Vaccinium pennsylvanicum* Lam.), the sour-top or velvet-leaf blueberry *(V. canadense* Kalm.) and the late low blueberry *(V. vacillans* Kalm.). Of these the first is the most common, the most desirable, and the one chiefly gathered for canning. Growers often speak of black and of white blueberries. The black blueberries are botanically a form of *V. pennsylvanicum* Lam., namely var. *nigrum* Wood. These are not uncommon, and are in every way desirable. The white blueberries are rare; they may be either *V. pennsylvanicum* Lam. forma *leucocarpum* Deane or *V. canadense* Kalm. forma *chiococcum* Deane.

In eastern Maine, the blueberry is in flower about the middle of May, and on the barrens the fruit begins to ripen quite generally by the end of July. During the berry season which lasts from early August until into September, the pickers move out to the barrens with their families, and live in shacks or tents, so that the plains appear not unlike an army encampment.

[2]Blueberries are widely distributed elsewhere throughout the state, but for the most part they grow only in pastures and waste land, and until recently there has been no real blueberry industry outside of Washington County, although the fresh fruit has been, and is, gathered quite generally for local use. Of late years the packing of blueberries has been more widespread, and considerable care has been paid to the growth of this crop in other parts of the state, especially near Rockland and Portland. As on the barrens, it is the low bush varieties which are gathered for canning, especially *V. pennsylvanicum*. Two species of high bush blueberries, *V. corymbosum* L. and *V. atrococcum* (Gray) Heller occur in the state, usually in moister localities, but so far as the writers know, are comparatively little used.

Although the berries, which are picked with a rake similar to that used for gathering cranberries. are under favorable conditions as firm and clean as hand picked fruit, usually more or less foreign matter is collected in the process of raking. It is a common though not a universal practice to winnow the berries in the field for the purpose of eliminating such leaves and other foreign material as can be blown out by the hand-power winnowing machine. The fruit is then poured into wooden boxes, and taken to the canneries. Before it is packed, it is subjected to a more thorough winnowing in a power-driven machine.

Although the blueberry stands transportation well, comparatively little of the fruit is shipped fresh on account of the high rates charged, and most of the berries are sold directly to the canneries and to the local markets. Washington County with its 13 canneries is the principal home of the blueberry industry in this state. Other canneries for blueberries located outside of this county are in Amherst, Belfast, Bucksport, Castine, Sargentville, Sedgwick, Thomaston and Waldoboro.

In 1886 when the first attempt was made to pack blueberries, 5,000 bushels were put up; in 1912, this had increased to some 90,000 bushels; while in 1922, 184,450 bushels were handled at the factories, and the value of the canned product was estimated at $1,000,000.

It has been the common practice to burn the blueberry bushes every third year, although occasionally the land is allowed to lie unburned for as many as 5 years or even longer. As a rule. each owner divides his land into 3 approximately equal lots which are burned in rotation, one each year. No berries are produced on the "new burn" (by which is meant the first year's growth of bushes after burning) but the second year the bushes bear very heavily, and somewhat less heavily in succeeding years, the reason being that the fruit is produced on the new wood developed during the preceding year. All the stems above ground and leaves are destroyed in the burning and only the tangled mass of roots remains, so that there is a very vigorous growth during the first year, but decidedly less the second year as so much energy must be expended in developing the berries. The fires are set on a clear morning in the spring and sweep across the barrens all day but are checked by the heavy dews in the evening.

The advantages of such burning are apparent both as to pruning the blueberry bushes and restraining of tree and weed-

bushes which would otherwise shade the plains. The effect of continued burning on the necessary acidity of the soil, however, is a matter which should be investigated with reference to cultural practices in the future.

NOTES ON THE BLUEBERRY MAGGOT.[3]

A long list of insects which attack either the foliage or the fruit of the blueberry might be drawn up, but at least in Washington County, Maine, only one is of serious economic importance. This is the blueberry maggot known technically as *Rhagoletis pomonella* Walsh as it is considered to be a biological strain of the well-known apple-maggot, or railroad worm, though characterized by a smaller size, shyer behavior and different food habits.

Like the other Diptera or two-winged flies, the order to which the blueberry maggot belongs, there are four stages in the life cycle of this insect, the egg, the larva, the pupa, and the adult or imago. In this last stage, the insect is a little dark fly, somewhat smaller than the common house fly, with black bands on the wings. These flies, which may be found in the field from mid-July until frost, deposit eggs in the ripe fruit. In a few days these eggs hatch into larvae, commonly known as maggots which live in the fruit about two weeks, causing "wormy" blueberries. When full fed the maggot leaves the berry and burrowing into the soil changes into a pupa, enclosed in a barrel shaped covering, the puparium, which is really the last larval skin. The winter is passed in this condition, but in the following summer the pupa transforms into the adult or fly. This generation of flies deposits eggs in the berries and thus the life cycle is repeated once and only once each year.

THE ADULT OR FLY.

Although the total number of individual flies on the whole extent of the barrens must be very large they are nowhere easy

[3]These notes are compiled from the records of four seasons' work on the barrens. The observations during 1913, 1914, 1915 were made in the vicinity of Cherryfield by the junior author. (See Bulletin 244, Maine Agricultural Experiment Station). In 1922 different localities from Harrington to Jonesboro were visited by both authors.

to find and the capture of 20 or so in a day calls for 8 or 9 continuous hours on the plains, and even then usually one sees but 10 or 12. It is possible that when their habits are better known, it will be easier to find them.

In 1913 two trips were made to the plains, the first on July 30 and the second on August 14. Adults were present on both dates. Rather more data are available for 1914. On July 2 the first visit was made to the plains for that year. No flies apparently had yet emerged. An attempt to dig out puparia was partially successful for a few were obtained, but this is a difficult procedure partly because, as the puparia are so scattered, much soil must be sifted in order to find only a few, and partly because the tangled mass of roots and underground stems renders digging very difficult. No flies emerged from any of these puparia and subsequent examination showed that all were dead, probably because they were dug on "new burn." On July 20 a few adult flies were captured and it seems fair to assume that they began to emerge about the middle of the month. They were observed during August and as late as September 10.

It has not yet been ascertained how long after emerging, the blueberry fly lives before she deposits eggs.[4]

There is one very striking difference in the behavior of the adult flies of the apple maggot and those of the blueberry maggot. Whereas on the apple the flies are rather sluggish, so that it is easy to watch oviposition in the field, on the blueberry they are very alert and shy, and oviposition in the field has not yet been observed. The adults suddenly appear on the berries seemingly as if they had just sprung into existence, and are so active that it is no easy task to take them captive, a decided contrast to the larger, comparatively sluggish apple flies.

The adults are restless in confinement and they seem loath to oviposit in captivity but the junior writer has witnessed the process once. Then it took place just as has been described for the apple maggot. The fly walked over the surface of the berry and finally stopped, head downward. Lifting her abdomen, she thrust out her ovipositor and made a slit at an angle of 45 degrees in

[4]Doctor Illingworth (Cornell Exp. Sta. Bul. 324, p. 143) records the time as 24 days for specimens of *Rhagoletis pomonella* bred from apple. In his bulletin is published a detailed account, with figures, of the development of the eggs in the female.

which she deposited a single egg just below the surface. This occupied about 2 minutes. Unfortunately this egg did not develop. Eggs in a number of instances, which have been found in ripe berries in the field, hatched within 24 hours after they were collected but it was not known how long before they had been laid. It is thought, however, that the egg period in the blueberry does not exceed 2 or 3 days.

At all events these data are sufficient to show that in the case of the blueberry maggot as with the apple maggot, the egg is deposited directly in the fruit and not in the blossom; for the adults do not emerge until fully 6 weeks after the bushes have flowered.

THE LARVA OR MAGGOT.

The observations of four different years indicate that a few maggots can be found early in August but they are at first so small that they readily escape detection. From the time the maggots first appear they become for a while increasingly abundant. This is indicated in counts made in 1922. On August 12, an examination was made of 1000 berries taken from a location within an area of rather heavy infestation. They were found to be 3.5% maggoty. Four days later an examination of 500 berries from the same place gave a count of 10.4% maggoty fruit. Similar counts in a second locality nearby, but subject to heavier infestation, showed a 6.9% infestation on August 12 and a 22.0% infestation on August 16.

During the days August 12-16, both dates inclusive, 12,000 berries in 500 and 1000-berry lots from different localities were opened and examined by the writers. During the first week in September, 11,000 berries from the same localities were opened and examined by the senior author and a field assistant. The percentage of berries containing maggots was shown by these counts to be higher on August 16 than in the first week in September. This does not, of course, mean that fruit after the first of September is in better condition than that picked before the middle of August, for soon after the middle of August there is an increasing number of berries that, judging from appearances, *had been* infested and from which the full-fed maggots had dropped. This season's investigations would indicate that while the maggots reached their maximum numbers soon after the

middle of August, they showed up more conspicuously after that date than before. The reasons for this seem to be the higher percentage of very small (young) maggots coupled with the greater firmness of the fruit early in the season, as over against the higher percentage of larger (halfgrown to full-fed) maggots coupled with the softer over-ripe berries later on. Although maggots were found in berries both in the general vicinity of Harrington and Jonesboro in August and September, the specific areas of infestation seemed characterized by localization. That is there were places near both these towns where the fruit was practically free from infestation; one count of 1000 berries near the former town taken August 14 registering only 0.5% maggoty and one count of 1000 berries near the latter town August 15 registering perfect fruit. On these same dates, not far from the same places centers of infestation were found where the fruit registered 7.6% maggoty for the former town and 6.7% maggoty for the latter. It should be said that in both cases the clean fruit was from "improved" land (regularly burned and with weed-bushes kept down) while the other count was taken from land not receiving the same care. While it should be emphasized that in general it was found that the fruit on the more "improved" land was conspicuously less subject to infestation than fruit from land not receiving much attention, the idea should not be conveyed that the percentage of infestation was high in all the neglected land for some thousand-berry counts of perfect fruit were made in pastures where the "weed-bushes" (birches etc.) were more than shoulder high.

Records taken in the field for four seasons show that by the middle of August maggots are present in all stages of growth from those just hatched to those which are full-fed and ready to leave the berries and pupate. Newly hatched maggots have been found as early as July 30 but only very young maggots are present the first week in August; and by September 10 chiefly maggots in their later stages of growth are found, there being comparatively few very young ones at this time. On August 18, 1922, August 21, 1914 and August 22, 1913 puparia were obtained, showing that by that time some of the insects had already completed their maggot-life within the berry and had entered the next or pupal stage. In 1914 a few larvae were reared under such conditions as to make sure the exact number of days passed

in the berry. One maggot which hatched August 18, was in the third instar on August 24, and formed its puparium on September 2. Two which hatched August 26, were in the last instar on September 2, were apparently full grown September 7, left their berries September 8, and formed puparia September 9. One which hatched August 28, was in the second instar September 2, and in the last instar September 8; the puparium was formed on September 14. One which was in the second instar on August 26, was in the last instar on September 2 and formed its puparium on September 7. These records indicate that the maggot spends on the average about 14 days in the berry and that the period spent during the last instar is nearly as long as the time of the two preceding instars together. The maggot attains its full growth in one berry, which it leaves by an irregular and jagged exit-hole. Only one maggot is found in a berry under natural conditions. Often the fruit falls off shortly before the maggot becomes full-fed, but it is not at all uncommon for it to remain on the bush after the maggot has entered the soil. In such cases the maggot doubtless works its way to the surface of the berry and then drops to the ground.

When ready to form their puparia, the larvae enter the soil which is of a sandy character on the barrens, but probably do not penetrate to a depth of much more than an inch. Under laboratory conditions they barely bury themselves beneath the surface in most cases. As is characteristic of this group of flies, pupation takes place within the last larval skin which is not molted but shrinks up and hardens, turning a light yellowish brown. Invariably the puparia are formed within 2 days after leaving the berry and usually within one. Transformation to the pupal stage takes place within 7 days after the puparia have been formed, usually about the fifth day.

HOST-PLANTS.

The blueberry fly has been bred at this Experiment Station from the three species of low blueberries, *(Vaccinium pennsylvanicum, V. canadense* and *V. vacillans.)* Mr. O'Kane[5] has recorded it from high bush blueberries, *(V. corymbosum).* This species has not been recorded at work in the mountain cranberry,

[5]N. H. Exp. Sta. Bul. 171, p. 18.

(V. Vitis-Idaea var. *minus,)* locally common on the plains. The huckleberry, *(Gaylussacia baccata,)* also common on the barrens, is subject to attack late in the season. The maggots do not seem to make much if any use of huckleberries on the barrens in August but when the blueberries are becoming scarce in early September, then the huckleberries are quite generally infested. Twice before, this insect has been reared from huckleberries *(Gaylussacia* sp.): once in Connecticut by Doctor Britton (Rpt. Conn. Sta. 1905, p. 200); and once in New Jersey by Doctor Smith (Insects of N. J., 1909, p. 802). Apparently this same race has been bred from snowberry *(Symphoricarpus racemosus* Michx.) in British Columbia by Downes, who confirms the writer's observations on the behavior of the adults. It is known from California also. (Can. ent. 1919 v. 51:2-4).

Chokeberry *(Pyrus melanocarpa),* is locally abundant on the plains but a careful search has failed to reveal any maggots in this fruit. The junior writer did succeed in making transfers and very small larvae removed from huckleberries and blueberries attained their growth and formed puparia when placed in chokeberries.

For one very peculiar fact of distribution it is hard to offer a satisfactory explanation. In Maine, although as an apple pest *Rhagoletis pomonella* is widely distributed throughout the state, and although blueberries are found commonly everywhere in the state, the blueberry maggot has been found so far in economic numbers only in the Washington County area. It has been found in all parts of the county where berries have been examined. Maggots were also taken in berries collected in West Rockport, the season of 1922. No maggots have been found in berries examined in previous years from other parts of the state (Orono and vicinity, Ellsworth, Mount Desert, Searsport, Auburn, Kineo, and the Katahdin region) nor this year in berries gathered in Gray and Brunswick in Cumberland County.

As has been stated, the flies bred from blueberries are so much smaller than those bred from apples that they can be distinguished at a glance. Although the apple maggot was very troublesome in the orchards of Cherryfield in 1914 neither there nor elsewhere were any flies that were subnormal in size observed on the apples. These observations are in accord with those made by Mr. W. C. O'Kane in New Hampshire.

Several attempts were made, both in the laboratory and in the field to induce the fly of the apple maggot to lay eggs in blueberries; but without success. A large cage was placed over a healthy blueberry plant, and about 20 adult flies just captured on apple were introduced, but they refused to oviposit. This was done twice in the field and on a smaller scale several times in the laboratory and insectary, always with negative results. At various times during the summer some 20 or more half-grown blueberry maggots were introduced into apples of various kinds, being inserted beneath the skin in such a way that they could burrow into the pulp before drying up, but not a single one developed sufficiently to form a puparium. Likewise flies taken on blueberries did not oviposit in apples, but as they also showed so much reluctance in the laboratory to oviposit at all, even in blueberries, one should not lay too much stress on this point.

At any rate the writers are inclined very strongly to the belief that biologically at least there are two distinct strains or races of *Rhagoletis pomonella* Walsh, the one breeding in the apple and related fruits and the other in smaller fruits such as the blueberry and huckleberry. In so far as *Rhagoletis* occurs in Maine the form on the apple and the form on the blueberry seem to be independent. The "oldest inhabitant" of the barrens cannot remember a time when there were not maggots in the blueberries, while the introduction and spread of the apple maggot in the state is a matter of record and is discussed by Professor Harvey in the Annual Report of this Experiment Station for 1889 and subsequent years. In Maine the blueberry maggot apparently did not migrate to the apple nor *vice versa* and the two races have lived on independently side by side.

NATURAL ENEMIES.

A parasite[6] belonging to the same order of insects as the wasps preys upon the maggots and no doubt plays its part in the "balance of nature" relative to the blueberry maggot. This insect was bred in considerable numbers from puparia obtained from blueberries in 1913. Under laboratory conditions the adults emerged at various times between February 25, and April 21,

[6]A braconid parasite, *Opius melleus* Gahan (of which *Biosteres rhagoletis* Richmond is a synonym).

1914, from the pupae of the blueberry maggot. Specimens of this species were collected on the blueberry barrens of Washington County during the summer of 1914. Adults were observed quite commonly on the barrens hovering about the blueberry bushes on August 26, 1915. They were rather slow moving and not very shy. In one case fortunately the process of oviposition was witnessed by the junior writer. The long ovipositor was thrust its full length into the berry. Judging from the date of pupation the maggot was very young when the egg of the parasite was deposited in it. It is, therefore, a larval parasite although the parasitized larva grows normally and forms its puparium. In the field the parasite doubtless passes the winter protected within the puparium of the host and does not emerge until midsummer or later.

Insect-eating birds are present on the barrens and undoubtedly capture many of the flies that would otherwise live to deposit eggs.

Control Measures with Reference to the Canning Industry.

During the season of 1922, 35 collections of blueberries were made in different parts of the blueberry plains of Washington County by the writers and a field assistant. Altogether we gathered, broke open (one at a time with our fingers) and examined 23,000 berries. The range and locality and conditions and percentage of infestation were recorded; but the items which form a basis for this discussion are of a local character and can be omitted from a general account. It should be emphasized, moreover, that the territory is too large and varied and the problem too complex to be solved by four seasons' observations and the examination of 35 collections of fruit. The economic phases of the situation merit detailed study and experimental work. The suggestions which follow are the best we can do at present but they lay no claim to adequacy.

1. *Early canning.* While in uninfested localities there is no entomological reason for haste in picking, it seems safe to draw the conclusion that berries from badly infested areas should be canned by the middle of August if evidence of the maggot is to be excluded from the pack. If some method of eliminating the green fruit at the factory could be devised, thus doing away with

the only objection to early canning, the advantage would be two-fold, insuring maggot-free berries and at the same time fruit of better quality than the later product; because in waiting for the last fruit of the cluster to ripen, (smaller and poorer than the rest) the largest and best of the fruit gets past its prime and in many cases even drops from the bushes and is lost altogether.

2. *Speed in handling the fruit.* In addition to the urge for early picking, with its double advantage of firm and maggot-free fruit, emphasis should also be put upon speed in handling the berries after they are picked. The use of the automobile for carrying the fruit from field to factory, and the practice in certain canneries, at least, of running an occasional night shift during the height of the season might indicate that a plea for speed is superfluous. There is, however, a valid entomogolical reason for emphasizing this point as may be illustrated by the following data. In one place, 1000 berries were gathered, 500 of these were examined at once and found to be 6.2% maggoty. The other 500 were stored for 48 hours when they were examined and found to be 7.0% maggoty. This indicated that in approximately one berry out of every hundred a maggot, either unhatched or so small as to escape detection on the first day, could be found showing up two days later.

So far the discussion has been confined to considerations relative to excluding the maggot from the pack. If we turn now to the possibilities of combative measures directed against the blueberry maggot there would seem to be several methods of attack.

3. *The destruction of the maggot in the fruit.* From a purely remedial-measures standpoint, of course, the more maggoty berries gathered and cooked, the better. The logical corrolary to this proposition is a program of clean picking and late picking. It is obvious that if the raking could be continued until September 1 or later, and the fruit cooked, the numbers of maggots in the field would be reduced and, as a consequence, the next season's egg-laying flies would be substantially fewer.

4. *The destruction of the pupae in the soil.* The full-fed maggots leave the fruit and pupate in the ground near the surface. In this dormant condition, they pass the winter. It was found several years ago that pupae collected from burned ground did not emerge. Though more extended experimental work

would be advisable in this connection, there would seem to be no more effective weapon to direct against this insect than fire — a weapon successfully used against hibernating meadow insects under certain conditions. The fact that, in general, even in the vicinity of badly infested areas, the better "improved" blueberry fields showed a low percentage of infestation, is probably largely due to the present practice of burning over the land. *If we could consider, in this connection, the entomological phase alone,* especial stress would be placed on this practice and its extension urged to a biennial burning of waste land (where such exists) immediately adjoining the "improved" fields. We do not, however, feel justified in urging more extensive burning than is now practiced until there are definite data as to its effects on the soil from the standpoint of the blueberry.

5. *Preventing the flies from depositing eggs.* In addition to the destruction of the pupae in the soil, the practice of burning serves a second entomological purpose. The "new-burn" does not fruit and such an area is of necessity free from maggots in the summer, free from hibernating pupae during the winter, and free from emerging flies the following summer. Fortunately similar results can be obtained so far as securing an area without fruit for a season, by cutting the bushes, or by ploughing them under. Both of these cultural methods, we are told, are practiced to a limited extent, and are to be commended as combative treatment in the case of the maggot, whatever their status may be with reference to blueberry horticulture in general.

6. *Clean picking.* In so far as is practicable, emphasis might well be placed on leaving as little ungathered fruit as possible. Bushes in or bordering a field which are so situated that they cannot be raked would better be cut down with other weed-bushes than left to breed maggots. The same may be said with reference to areas occupied by "sour-top" or "velvet-leaf" blueberry *(Vaccinium canadense),* and huckleberry *(Gaylussacia baccata),* both of which species are liable to infestation and, if left to bear ungathered fruit, become breeding places for the maggots.

7. *The destruction, where practicable, of wind breaks.* As has been indicated in the body of the bulletin, certain areas are much more badly infested than others near at hand. There are reasons to think that wind exposure may determine such local abundance of the maggots. Wherever especially heavy intesta-

tions so far have been noted, there have been bushes or rocks which would give shelter to the fly from the wind while she is ovipositing. Although in places, uninfested fruit was found in neglected pastures, there was in general a conspicuous coincidence of low percentage of infestation with low percentage of sheltering weed-bushes. It may be found that the areas which are wind swept are, because of that, better protected from visits by the egg-laying fly.

8. *The destruction of waste at the cannery.* Infested fruit hauled to the factory and refused as unfit to pack should not be dumped in such a way as to give the maggots a chance to develop and start a center of infestation. The disposal of such material should be provided for. It might be burned, cooked, or buried according to local convenience. On general principles, too, it would probably be safer to dispose of the waste at the sorting tables and the factory winnowings by burning or burying, or otherwise treating it so as to destroy maggots if they are present in such refuse. Spraying with kerosene preparations or heavier oils might be a feasible treatment.

CONCLUDING COMMENT.

This report on the blueberry industry, entomologically considered, records our acquaintance with the situation so far as it extends at present. It should, of course, be interpreted as an initial statement for the problem is too big to be conclusively handled in the time and with the facilities that have been available, so far.

Indeed some of the factors of its bigness are increasingly more apparent; for the past season has again demonstrated that the adage, "no man lives by himself alone," applies to the entomologist with particular fitness. For if we urge earlier picking, an efficiency expert must needs devise some method of eliminating green berries from the pack. If we urge continuous and late picking, a market must be provided for the late-season product. We cannot unreservedly recommend burning if the chemist denounces the practice in the interests of soil acidity; or cutting or ploughing, if such methods do not meet the approval of the horticulturalist.

As a matter of fact, the problem is big, partly because it, like all other agricultural projects, is a complex, calling for cooperative study by biologist, chemist, entomologist, horticulturalist, and plant pathologist.[7]

[7]The latter being indicated by the discovery, on one of the best grounds, of blueberry rust *(Calyptospora columnaris)* present to an injurious, if not to an alarming, extent.

FIGURE 2.

Fly *(Rhagoletis pomonella)*. Greatly enlarged.

A. Female fly with ovipositor extended.
B. Male fly.
C. Tip of abdomen of female fly showing the ovipositor with which the fly inserts the egg into the fruit.
D. Eggs. These are laid directly in the fruit and hatch in a short time.
E. Maggot, which hatches from the egg and attains its full growth in the fruit.
F. Pupa. After the maggot becomes full grown it drops from the fruit and pupates near the surface of the soil. It remains in this stage until the next summer when the adult fly emerges from the puparium.

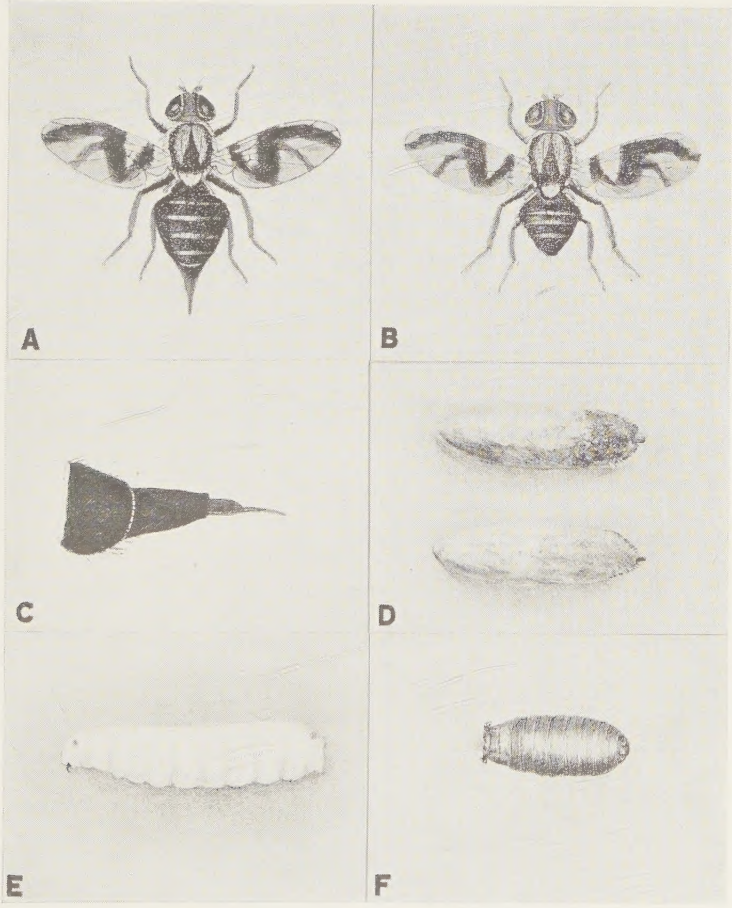

FIG. 2.